Septic Systems

When examining the business census data for lithographers and the EPA's data for waste water treatment facilities, it was noted that there are counties which do not have any POTWs. While some of the Agency's data is probably in error, there are still a significant minority of lithographers who do not appear to release water to a waste water treatment plant. These printers are assumed to release to septic systems or have no water releases at all. The releases of this type are not modeled in this assessment. Some general guidelines may be used to determine if there will be exposure to any of the blanket wash chemicals from septic system seepage. Each chemical will have an estimated potential migration to ground water, usually used for landfill assessments. This can be directly applied to septic systems, because the potential to migrate to ground water will be the same. Of course the individual characteristics of the system will determine the actual speed that each chemical travels into the ground water. If the septic system is relatively leaky, and the ground water table is relatively high, the time that a chemical takes to get into the ground water will be shorter than for a septic system which is well sealed and where the ground water table is low.

Landfill

Our usual techniques for estimating cumulative exposures from landfill releases are not applicable to printing. For large-scale industrial processes, we assume that one facility sends waste to a landfill via a waste handler. For the printing industry, it is not reasonable to simplify the situation to that extent. A lack of data limits the determination of exposures. For instance, we do not know how many printers are sending what types of wastes to any given landfill. Some printers send part of their wastes to a hazardous waste handler, and another portion to the county landfill. For these reasons, although the exposures from landfill releases may be significant, we cannot calculate exposures from landfill seepage and migration into ground water. However, we can give the expected fate for the chemical in the landfill - will the chemical migrate to ground water rapidly, moderately or negligibly.

3.4 RISK CHARACTERIZATION

3.4.1 Background

Assessment of the human health risks presented by chemical substances includes the following components of analysis:

1) Hazard Identification is the process of determining whether exposure to a chemical can cause an adverse health effect and whether the adverse health effect is likely to occur in humans.

2) Dose-response Assessment is the process of defining the relationship between the dose of a chemical received and the incidence of adverse health effects in the exposed population. From the quantitative dose-response relationship, toxicity values are derived that are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels.

3) Exposure Assessment identifies populations exposed to a chemical, describes their composition and size, and presents the types, magnitudes, frequencies, and durations of exposure to the chemical.

4) Risk Characterization integrates hazard and exposure information into quantitative and qualitative expressions of risk. A risk characterization includes a description of the assumptions, scientific judgments, and uncertainties embodied in the assessment.

Quantitative Expressions of Hazard and Risk

The manner in which estimates of hazard and risk are expressed depends on the nature of the hazard and the types of data upon which the assessment is based. For example, cancer risks are most often expressed as the probability of an individual developing cancer over a lifetime of exposure to the chemical in question. Risk estimates for adverse effects other than cancer are usually expressed as the ratio of a toxicologic potency value to an estimated dose or exposure level. A key distinction between cancer and other toxicologic effects is that most carcinogens are assumed to have no dose threshold, i.e., no dose or exposure level can be presumed to be without some risk. Other toxicologic effects are generally assumed to have a dose threshold, i.e., a dose or exposure level below which a significant adverse effect is not expected.

Cancer Hazard and Risk

EPA employs a "weight-of-evidence" approach to determine the likelihood that a chemical is a human carcinogen. Each chemical evaluated is placed into one of the five weight-of-evidence categories listed below.

Group A --	human carcinogen
Group B --	probable human carcinogen. B1 indicates limited human evidence; B2 indicates sufficient evidence in animals and inadequate or no evidence in humans.
Group C --	possible human carcinogen
Group D --	not classifiable as to human carcinogenicity
Group E --	evidence of noncarcinogenicity for humans

When the available data are sufficient for quantitation, EPA develops an estimate of the chemical's carcinogenic potency. EPA "slope factors" express carcinogenic potency in terms of the estimated upper-bound incremental lifetime risk per mg/kg average daily dose. "Unit risk" is a similar measure of potency for air or drinking water concentrations and is expressed as risk per $\mu g/m^3$ in air or as risk per µg/L in water for continuous lifetime exposures.

Cancer risk is calculated by multiplying the estimated dose or exposure level by the appropriate measure of carcinogenic potency. For example an individual with a lifetime average daily dose of 0.3 mg/kg of a carcinogen with a potency of 0.02 mg/kg/day would experience a lifetime cancer risk of 0.006 from exposure to that chemical. In general, risks from exposures to more than one carcinogen are assumed to be additive, unless other information points toward a different interpretation.

Chronic Health Risks

Because adverse effects other than cancer and genetic toxicity are generally assumed to have a dose or exposure threshold, a different approach is needed to evaluate toxicologic potency and risk for these "systemic effects." "Systemic toxicity" means an adverse effect on any organ system following absorption and distribution of a toxicant to a site in the body distant from the toxicant's entry point. EPA uses the "Reference Dose" approach to evaluate chronic (long-term) exposures to systemic toxicants. The Reference Dose (RfD) is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime" and is expressed as a mg/kg/day dose. The RfD is usually based on the most sensitive known effect, i.e., the effect that occurs at the lowest dose. EPA calculates a comparable

measure of potency for continuous inhalation exposures called a Reference Concentration or RfC, expressed as a mg/m^3 air concentration. Although some RfDs and RfCs are based on actual human data, they are most often calculated from results obtained in chronic or subchronic animal studies. The basic approach for deriving an RfD or RfC involves determining a "no-observed-adverse-effect level (NOAEL)" or "lowest-observed-adverse-effect level (LOAEL)" from an appropriate toxicologic or epidemiologic study and then applying various uncertainty factors and modifying factors to arrive at the RfD/RfC. Each factor represents a specific area of uncertainty. For example, an RfD based on a NOAEL from a long-term animal study may incorporate a factor of 10 to account for the uncertainty in extrapolating from the test species to humans and another factor of 10 to account for the variation in sensitivity within the human population. An RfD based on a LOAEL typically contains another factor of 10 to account for the extrapolation from LOAEL to NOAEL. An additional modifying factor (between 1 and 10) is sometimes applied to account for uncertainties in data quality.

RfDs and RfCs can be used to evaluate risks from chronic exposures to systemic toxicants. EPA defines an expression of risk called a "Hazard Quotient" which is the ratio of the estimated chronic dose/exposure level to the RfD/RfC. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater is the level of concern. However, it is important to remember that the Hazard Quotient is not a probabilistic statement of risk. A quotient of 0.001 does not mean that there is a one-in-a-thousand chance of the effect occurring. Furthermore, it is important to remember that the level of concern does not necessarily increase linearly as the quotient approaches or exceeds unity because the RfD/RfC does not provide any information about the shape of the dose-response curve.

An expression of risk that can be used when an RfD/RfC is not available is the "Margin-of-Exposure (MOE)." The MOE is the ratio of a NOAEL or LOAEL (preferably from a chronic study) to an estimated dose or exposure level. Interpretation of an MOE employs the same approach to uncertainty as the RfD does. An MOE value high enough to account for the uncertainties in extrapolating from the experimental data to a likely no-effect level in humans implies a low level of concern. For example, MOE values such as values greater than 100 for a NOAEL-based MOE (to account for interspecies and intraspecies variability) or 1000 for a LOAEL-based MOE (to account for interspecies and intraspecies variability and LOAEL to NOAEL extrapolation) indicate low concern. As the MOE decreases, the level of concern increases. As with the Hazard Quotient, it is important to remember that the MOE is not a probabilistic statement of risk.

Developmental Toxicity Risks

Because of the many unique elements associated with both the hazard and exposure components of developmental toxicity risk assessment, these risks are treated separately from other systemic toxicity risks.

EPA defines developmental toxicity as adverse effects on the developing organism that may result from exposure prior to conception, during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the life span of the organism. The major manifestations of developmental toxicity include: (1) death of the developing organism, (2) structural abnormality, (3) altered growth, and (4) functional deficiency.

There is a possibility that a single exposure may be sufficient to produce adverse developmental effects. Therefore, it is assumed that, in most cases, a single exposure at any of several developmental stages may be sufficient to produce an adverse developmental effect. In the case of intermittent exposures, examination of the peak exposure(s) as well as the average exposure over the time period of exposure is important.

EPA has derived RfDs and RfCs for developmental toxicants in a similar manner to the RfDs and RfCs for other systemic toxicants. The RfD_{DT} or RfC_{DT} is an estimate of a daily exposure to the human population that is assumed to be without appreciable risk of deleterious developmental effects. The use of the subscript DT is intended to distinguish these terms from the more common RfDs and RfCs that refer to chronic exposure situations for other systemic effects.

Developmental toxicity risk can be expressed as a Hazard Quotient (dose or exposure level divided by the RfD_{DT} or RfC_{DT}) or Margin-of-Exposure (NOAEL or LOAEL divided by the dose or exposure level), with careful attention paid to the exposure term, as described above.

NOTE: The closely related area of reproductive toxicity is also an important aspect of systemic toxicity. For purposes of this report, toxicity information on adult male and female reproductive systems will be assessed as part of the chronic toxicity risk.

Decision Criteria

"Concerns" are cases in which the estimated hazard quotient is ten or greater or in which the estimated margin-of-exposure (MOE) is much less than 100 (based on a no-observed adverse effect level (NOAEL)) or much less than 1000 (based on a lowest-observed adverse effect level (LOAEL)).

"Possible concerns" are cases in which the estimated hazard quotient is between one and ten or in which the estimated margin-of-exposure is slightly less than 100 (based on a no-observed adverse effect level) or slightly less than 1000 (based on a lowest-observed adverse effect level) or cases in which the concern is mitigated by other considerations such as absorption rates.

"Low or negligible concerns" are cases in which the estimated hazard quotient is less than one or in which the MOE_{NOAEL} is greater than 100 or the MOE_{LOAEL} is greater than 1000.

Assumptions and Uncertainties

Estimated doses assume 100 percent absorption. The actual absorption rate may be significantly lower, especially for dermal exposures to relatively polar compounds. The assessment used the most relevant toxicological potency factor available for the exposure under consideration. In some cases the only potency factor available was derived from a study employing a different route of exposure than the exposure being evaluated, e.g., oral RfD values were sometimes used to calculate Hazard Quotients for inhalation and dermal exposures. Most of the Margin-of-Exposure calculations presented in the assessment are based on toxicity data that have not been formally evaluated by the Agency. Because of the small contribution of inhalation exposure to the total dose (<1% for most chemicals), combined dose MOEs were not calculated.

Worker dermal exposure values should be regarded as “bounding estimates,” i.e., calculated exposures are expected to be higher than any actual exposure levels. Exposure estimates for all other pathways (worker inhalation, general population exposure via ambient air, drinking water and fish) should be regarded as “what if” estimates. The “what if” scenarios are based on information on product usage and work practices obtained from industry surveys. No actual measures of chemical release or exposure were available. The scenarios are intended to represent a plausible set of circumstances under which exposures could occur. However, not enough information is available to estimate the probability of these circumstances actually occurring. Thus, it is not possible to predict where the calculated values fall in the exposure distribution, i.e., the resulting exposure and risk estimates cannot be characterized as “central tendency,” “high end,” etc.

A number of the chemicals of concern have only a limited toxicologic data base. The calculated risks for trimethylbenzene, light aromatic naphtha, linalool, butyrolactone, Stoddard solvent, and diethanolamine are based on LOAEL values from studies that did not reach a NOAEL. The available studies on these chemicals are generally limited in scope and do not address all major toxicologic endpoints.

3.4.2 Ecological Risk

The basic elements of ecological risk assessment are similar to those employed in human health risk assessment. Because of the limited toxicological data available for the lithographic blanket wash chemicals, this report will only address ecological risks to aquatic species. Risks to terrestrial species will not be assessed. Quantitative evaluation of aquatic risks involves comparing a predicted ambient water concentration to a "concern concentration" for chronic exposures to aquatic species. The concern concentration may be based either on actual toxicologic test data on the subject chemical or on quantitative structure-activity relationship analysis of test data on similar chemicals. The concern concentration is typically expressed as a mg/L water concentration. Exposure concentrations below the concern concentration are assumed to present low risk to aquatic species. Exposures that exceed the concern concentration indicate a potential for adverse impact on aquatic species. The level of concern increases as the ratio of exposure concentration to concern concentration increases.

A number of formulations present concerns with respect to potential impacts on aquatic species resulting from water releases. Only two chemical classes had estimated concentrations in a hypothetical receiving stream (a relatively small stream at low flow conditions) that exceeded the “concern concentration” for that chemical class. Predictions based on actual streamflow data for the South Platte River support these conclusions. Most of the excesses in the hypothetical stream are also excesses in the South Platte River, in some cases at mean flow as well as low flow conditions.

The following two chemicals exceeded the aquatic concern concentrations: alkyl benzene sulfonates and ethoxylated nonylphenols, which are present in Formulations 3, 5, 6, 8, 11, 18, 20, and 24, and in Formulations 4, 5, 7, 8, 9, 17, 24, and 40, respectively.

A table of the concern concentration estimates for aquatic species follows (Table 3-7):

Assumptions and Uncertainties

All estimated water concentrations are based on release estimates developed from “what if” scenarios constructed from industry surveys and assumptions reviewed by industry experts of product usage and work practices. No actual measures of chemical release or exposure levels were available.

Table 3-7. Risks to Aquatic Species from Blanket Wash Chemicals

Form. Number	Chemical Components	Stream concentrations (mg/L)			Concern conc "cc" (mg/L)	Low[1] flow conc/ "cc"
		50th %ile	10th %ile	10th %ile		
		Mean flow	Mean flow	Low flow		
1	Fatty acid derivatives Alkoxylated alcohols					
3	Hydrocarbons, petroleum distillates Fatty acid derivatives Hydrocarbons, aromatic Alkyl benzene sulfonates	 7×10^{-5} 5×10^{-5}	 6×10^{-4} 4×10^{-4}	 4×10^{-2} 3×10^{-2}	 * 1×10^{-3}	 3×10^{1}
4	Terpenes Ethoxylated nonylphenol[2]	 1.56×10^{-4}	 1.182×10^{-3}	 7.8×10^{-2}	 1×10^{-3}	 78
5	Water Hydrocarbons, aromatic Ethylene glycol ethers Ethoxylated nonylphenol[2] Alkyl benzene sulfonates Alkoxylated alcohols Alkali/salts	 2.0×10^{-5} 5×10^{-6} 1×10^{-4} 0	 1.52×10^{-4} 3.9×10^{-5} 9×10^{-4} 0	 1.0×10^{-2} 2.6×10^{-3} 6×10^{-2} 0	 1×10^{-3} 2×10^{-3} 2×10^{-1}	 10 1 3×10^{-1}
6	Fatty acid derivatives Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Alkyl benzene sulfonates	2×10^{-4} 6×10^{-6}	1×10^{-3} 5×10^{-5}	8×10^{-2} 3×10^{-3}	* 1×10^{-3}	 3
7	Terpenes Ethoxylated nonylphenol[2] Alkoxylated alcohols	 6×10^{-6} 2×10^{-5}	 4.5×10^{-5} 1×10^{-4}	 3.0×10^{-3} 9×10^{-3}	 1×10^{-3} 1×10^{-1}	 3 9×10^{-2}
8	Water Hydrocarbons, aromatic Propylene glycol ethers Alkyl benzene sulfonates Ethoxylated nonylphenol[2] Alkoxylated alcohols Alkali/salts	 1.11×10^{-4} 1.7×10^{-5} 1×10^{-4} 0	 8.08×10^{-4} 1.29×10^{-4} 8×10^{-4} 0	 4.95×10^{-2} 8.5×10^{-3} 5×10^{-2} 0	 $1\times10^{+1}$ 1×10^{-3} 2×10^{-1}	 5×10^{-1} 8.5 3×10^{-1}
9	Fatty acid derivatives Water Ethoxylated nonylphenol[2]	2×10^{-4} 6×10^{-6}	1×10^{-3} 4.5×10^{-5}	1×10^{-1} 3×10^{-3}	* 1×10^{-3}	 3
10	Fatty acid derivatives Water	7×10^{-5}	5×10^{-4}	3×10^{-2}	*	
11	Fatty acid derivatives Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Alkyl benzene sulfonates	1×10^{-4} 3×10^{-5}	9×10^{-4} 2×10^{-4}	6×10^{-2} 2×10^{-2}	* 1×10^{-3}	 $2\times10^{+1}$
12	Hydrocarbons, petroleum distillates					
13	Hydrocarbons, petroleum distillates Terpenes					
14	Fatty acid derivatives Ethylene glycol ethers	3×10^{-5}	2×10^{-4}	1×10^{-2}	*	
16	Terpenes					

Form. Number	Chemical Components	Stream concentrations (mg/L)			Concern conc "cc" (mg/L)	Low[1] flow conc/ "cc"
		50th %ile	10th %ile	10th %ile		
		Mean flow	Mean flow	Low flow		
17	Ethoxylated nonylphenol[2] Propylene glycol ethers Fatty acid derivatives Alkali/salts Water	4×10^{-6} 2×10^{-6}	3.3×10^{-5} 2×10^{-5}	2.2×10^{-3} 1×10^{-3}	1×10^{-3} 2	2.2 5×10^{-4}
18	Fatty acid derivatives Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Dibasic esters Esters/lactones Alkyl benzene sulfonates	1×10^{-4} 3×10^{-5}	8×10^{-4} 2×10^{-4}	5×10^{-2} 2×10^{-2}	* 1×10^{-3}	 $2\times10^{+1}$
19	Fatty acid derivatives Ethylene glycol ethers	9×10^{-5}	7×10^{-4}	4×10^{-2}	*	
20	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Alkyl benzene sulfonates	 8×10^{-5}	 6×10^{-4}	 4×10^{-2}	 1×10^{-3}	 $4\times10^{+1}$
21	Hydrocarbons, aromatic Hydrocarbons, petroleum distillates Fatty acid derivatives	 2×10^{-5}	 2×10^{-4}	 1×10^{-2}	 *	
22	Fatty acid derivatives Hydrocarbons, aromatic	1×10^{-4}	1×10^{-3}	7×10^{-2}	*	
23	Terpenes Nitrogen heterocyclics Alkoxylated alcohols					
24	Terpenes Ethylene glycol ethers Ethoxylated nonylphenol[2] Alkyl benzene sulfonates Alkali/salts	 9×10^{-6} 8×10^{-6} 3×10^{-5}	 7×10^{-5} 6×10^{-5} 2×10^{-4}	 4.6×10^{-3} 4×10^{-3} 2×10^{-2}	 1×10^{-3} 3×10^{-2} 9×10^{-2}	 4.6 1×10^{-1} 2×10^{-1}
25	Terpenes Esters/lactones					
26	Fatty acid derivatives Esters/lactones	2.08×10^{-4} 8×10^{-6}	2.06×10^{-3} 6×10^{-5}	1.04×10^{-1} 4×10^{-3}	3×10^{-1} 3×10^{-1}	 1×10^{-2}
27	Terpenes					
28	Hydrocarbons, petroleum distillates					
29	Fatty acid derivatives	3×10^{-4}	2×10^{-3}	1×10^{-1}	*	
30	Hydrocarbons, aromatic Ethylene glycol ethers					
31	Hydrocarbons, aromatic Hydrocarbons, petroleum distillates					
32	Hydrocarbons, petroleum distillates					
33	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Propylene glycol ethers					

Form. Number	Chemical Components	Stream concentrations (mg/L)			Concern conc "cc" (mg/L)	Low[1] flow conc/ "cc"
		50th %ile Mean flow	10th %ile Mean flow	10th %ile Low flow		
34	Water Terpenes Hydrocarbons, petroleum distillates Alkoxylated alcohols Fatty acid derivatives	 6×10^{-5} 3×10^{-5}	 4×10^{-4} 3×10^{-4}	 3×10^{-2} 2×10^{-2}	 3×10^{-1} 7×10^{-2}	 1×10^{-1} 3×10^{-1}
35	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic					
36	Fatty acid derivatives Hydrocarbons, petroleum distillates Hydrocarbons, aromatic Propylene glycol ethers	2×10^{-4}	1×10^{-3}	9×10^{-2}	*	
37	Water Hydrocarbons, petroleum distillates Aliphatic hydrocarbon Hydrocarbons, aromatic					
38	Hydrocarbons, petroleum distillates Alkoxylated alcohols Fatty acid derivatives					
39	Water Hydrocarbons, petroleum distillates Propylene glycol ethers Alkanolamines Ethylene glycol ethers	 2×10^{-5}	 2×10^{-4}	 1×10^{-2}	 1	 1×10^{-2}
40	Hydrocarbons, aromatic Hydrocarbons, petroleum distillates Fatty acid derivatives Ethoxylated nonylphenol[2]	 9×10^{-6}	 6.7×10^{-5}	 4.4×10^{-3}	 1×10^{-3}	 4.4

[1] Low flow concentration/concern concentration; reported as mg/L

[2] Based on testing data (Weeks, J.A. et al. 1996. *Proceedings of the CESIO 4th World Surfactants Congress, Barcelona, Spain.* Brussels, Belgium: European Committee on Surfactants and Detergents, pp. 276-291.) the original estimate of POTW removal has been changed from 100% reported in the draft document to 95% in the final report. This revision results in increased estimates of releases to surface water. When the releases to surface water are compared with the concern concentration set at the default value of 0.001 mg/L, the formulations containing ethoxylated nonylphenols (formulations 4, 5, 7, 8, 9, 17, 24 and 40) present concerns to aquatic species that were not reported in the draft CTSA.

* No effects expected at saturation.

3.4.3 Occupational Risks

Most of the formulations (27/37) present at least some concern for dermal exposures to workers. A wide variety of chemicals trigger these concerns, which appear to be driven primarily by relatively high potential exposure levels. The calculated risks overestimate the actual risks because of the use of bounding estimates of exposure and the assumption of 100% dermal absorption. However, the margins of exposure are so low (below 10 for a number of chemicals) for most of the chemicals of concern that it is very likely that most of the identified concerns would remain if more realistic exposure estimates were available. Also, most of the chemicals of concern,

e.g., various petroleum hydrocarbons, glycol ethers, diethanolamine, are probably well-absorbed dermally.

Worker inhalation risks are very low for almost all of the formulations, reflective of the generally low exposure levels as seen in Table 3-8. Only one formulation (formulation number 3) triggered inhalation concerns.

A Margin-of-Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater is the level of concern. High MOE values such as values greater that 100 for a NOAEL-based MOE or 1000 for a LOAEL-based MOE imply a low level of concern. As the MOE decreases, the level of concern increases. The hazard values used in the HQ or MOE calculations were taken from Table 2-3. The exposure values used in the calculations were taken from Table 3-2. The absence of HQ or MOE values in this table indicates that insufficient hazard data were available to calculate a HQ or MOE for that chemical.

The calculated risk numbers should be viewed as low-confidence estimates because of the many uncertainties associated with both the hazard and exposure components of the calculation. However, most of the risk conclusions that follow can be regarded with moderate to high confidence because most of the conclusions are based on risk estimates that fall far above or far below standard risk benchmarks. Thus, the “true” risk value could vary substantially from the estimated value without changing the conclusion. In particular, conclusions of low concern generally can be regarded with high confidence because of the conservative approach (i.e. one that overestimates the risk) taken in the assessment. Conclusions based on small excesses of risk benchmarks should be viewed with low confidence, as should any conclusions based primarily on structure-activity predictions.

Table 3-8. Worker Occupational Risk Estimates

Form. Number	Chemical Components	Margin of Exposure (MOE)[1,2]	
		Dermal	Inhalation
1	Fatty acid derivatives		
	Alkoxylated alcohols		
3	Hydrocarbons, petroleum distillates		
	Fatty acid derivatives		
	Hydrocarbons, aromatic	10	4464
	Hydrocarbons, aromatic	1	33
	Hydrocarbons, aromatic	0.36 (HQ)	0.02 (HQ)
	Hydrocarbons, aromatic	1 (HQ)	0.02 (HQ)
	Alkyl benzene sulfonates		
4	Terpenes	5	236
	Ethoxylated nonylphenol	135	
	Ethoxylated nonylphenol	159	

Form. Number	Chemical Components	Margin of Exposure (MOE)[1,2]	
		Dermal	Inhalation
5	Water		
	Hydrocarbons, aromatic	10	1.8×10^{4}
	Ethylene glycol ethers	26	1.8×10^{5}
	Ethoxylated nonylphenol	117	
	Alkyl benzene sulfonates		
	Alkoxylated alcohols		
	Alkyl benzene sulfonates		
	Alkali/salts		
6	Fatty acid derivatives		
	Hydrocarbons, petroleum distillates	38	6233
	Hydrocarbons, aromatic		
	Alkyl benzene sulfonates		
7	Terpenes		
	Terpenes	22	1.8×10^{4}
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Ethoxylated nonylphenol	318	
	Alkoxylated alcohols		
8	Water		
	Hydrocarbons, aromatic		
	Propylene glycol ethers	200	4.1×10^{4}
	Alkyl benzene sulfonates		
	Ethoxylated nonylphenol	135	
	Alkyl benzene sulfonates		
	Alkoxylated alcohols		
	Alkyl benzene sulfonates		
	Alkali/salts		
9	Fatty acid derivatives		
	Water		
	Ethoxylated nonylphenol	455	
10	Fatty acid derivatives		
	Water		
11	Fatty acid derivatives		
	Hydrocarbons, petroleum distillates	21	4429
	Hydrocarbons, aromatic		
	Alkyl benzene sulfonates		

Form. Number	Chemical Components	Margin of Exposure (MOE)[1,2]	
		Dermal	Inhalation
12	Hydrocarbons, petroleum distillates		
	Hydrocarbons, petroleum distillates	73	7.0×10^{4}
	Water		
14	Fatty acid derivatives		
	Propylene glycol ethers		
	Water		
16	Terpenes	22	1.8×10^{4}
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
17	Ethoxylated nonylphenol	515	
	Propylene glycol ethers	0.05 (HQ)	6×10^{-6} (HQ)
	Fatty acid derivatives		
	Alkali/salts	5208	
	Water		
18	Fatty acid derivatives		
	Hydrocarbons, petroleum distillates	26	5803
	Hydrocarbons, aromatic		
	Dibasic esters	4	5405
	Dibasic esters	4	9091
	Dibasic esters	4	5263
	Esters/lactones		
	Alkyl benzene sulfonates		
19	Fatty acid derivatives		
	Propylene glycol ethers		
	Water		
20	Water		
	Hydrocarbons, petroleum distillates	84	9.4×10^{4}
	Hydrocarbons, aromatic		
	Alkyl benzene sulfonates		
21	Hydrocarbons, aromatic	13	4464
	Hydrocarbons, petroleum distillates	8	1336
	Fatty acid derivatives		
22	Fatty acid derivatives		
	Hydrocarbons, aromatic		
	Water		

Form. Number	Chemical Components	Margin of Exposure (MOE)[1,2]	
		Dermal	Inhalation
23	Terpenes	63	2.1×10^4
	Nitrogen heterocyclics	98	2.1×10^4
	Alkoxylated alcohols		
	Water		
24	Terpenes	28	7292
	Ethylene glycol ethers	83	7.8×10^5
	Ethoxylated nonylphenol	218	
	Alkyl benzene sulfonates	2	
	Alkali/salts		
	Water		
25	Terpenes		
	Terpenes	22	1.8×10^4
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Esters/lactones	218	1.5×10^4
26	Fatty acid derivatives		
	Esters/lactones	45	
	Fatty acid derivatives	151	
	Esters/lactones		
27	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes		
	Terpenes	455	3.6×10^5
	Terpenes		
	Terpenes		
28	Hydrocarbons, petroleum distillates	7	110
29	Fatty acid derivatives		
30	Hydrocarbons, aromatic	4	5168
	Propylene glycol ethers		
	Water		
31	Hydrocarbons, aromatic	17	1.1×10^4
	Hydrocarbons, petroleum distillates		
32	Hydrocarbons, petroleum distillates		

Form. Number	Chemical Components	Margin of Exposure (MOE)[1,2]	
		Dermal	Inhalation
33	Hydrocarbons, petroleum distillates	10	1.0×10^4
	Hydrocarbons, aromatic	11	2.2×10^4
	Propylene glycol ethers	3322	3.6×10^5
	Water		
34	Water		
	Terpenes	26	5147
	Hydrocarbons, petroleum distillates		
	Alkoxylated alcohols	140	
	Fatty acid derivatives		
35	Hydrocarbons, petroleum distillates		
	Hydrocarbons, aromatic	3	1.1×10^4
36	Fatty acid derivatives		
	Hydrocarbons, petroleum distillates	50	8014
	Hydrocarbons, aromatic		
	Propylene glycol ethers	1979	6.4×10^4
37	Water		
	Hydrocarbons, petroleum distillates		
	Hydrocarbons, aliphatic		
	Hydrocarbons, aromatic	100	1.5×10^5
38	Hydrocarbons, petroleum distillates		
	Alkoxylated alcohols		
	Fatty acid derivatives		
39	Water		
	Hydrocarbons, petroleum distillates	50	5.6×10^4
	Propylene glycol ethers	200	8.8×10^4
	Alkanolamines	25	
	Ethylene glycol ethers	83	4.5×10^5
40	Hydrocarbons, aromatic		
	Hydrocarbons, petroleum distillates	59	8415
	Fatty acid derivatives		
	Ethoxylated nonylphenol	318	

[1] A Margin-of-Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater is the level of concern. High MOE values such as values greater that 100 for a NOAEL-based MOE or 1000 for a LOAEL-based MOE imply a low level of concern. As the MOE decreases, the level of concern increases. The hazard values used in the HQ or MOE calculations were taken from Table 2-3. The exposure values used in the calculations were taken from Table 3-2.

[2] The absence of HQ or MOE values in this table indicates that insufficient hazard data were available to calculate a HQ or MOE for that chemical.

Below is a summary of risks found for each formulation. This summary is intended to convey the risks that these formulations may present under typical conditions of use. A summary of the toxicological endpoints associated with chemicals of concern is shown in Table 3-9.

Blanket Wash 1

Worker Risk

Risks for this formulation could not be quantified due to the unavailability of hazard values[d]. However, overall concern is low because of low inhalation exposure levels, poor dermal absorption, and low to moderate toxicologic concern based on structure-activity analysis.

Blanket Wash 3

Worker Risk - Dermal Exposure

Hazard quotient calculations indicate a concern for exposure to some aromatic hydrocarbons and very low concern for exposure to other aromatic hydrocarbons. However, the hazard values are based upon oral or inhalation studies. Margin of exposure calculations indicate concern for exposures to aromatic hydrocarbons. However, the hazard values are based upon inhalation studies. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values.

Worker Risk - Inhalation Exposure

Hazard quotient calculations indicate very low concern for exposure to aromatic hydrocarbons. However, the hazard value for one of these aromatic hydrocarbons is based upon an oral study. The RfD used to calculate the risk estimate is classified as "low confidence" by IRIS (Integrated Risk Information System). Margin of exposure calculations indicate concern for exposure to certain aromatic hydrocarbons, but very low concern for exposure to others. Due to negligible inhalation exposure, the alkyl benzene sulfonates and fatty acid derivatives used in this formulation present no concern. Risks for other chemicals in the formulation could not be quantified due to the unavailability of hazard values.

Blanket Wash 4

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to terpenes and low concern for exposure to the ethoxylated nonylphenols. However, the hazard value for terpenes is based upon an oral study.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate a very low concern for exposure to terpenes. However, the hazard value is based upon an oral study. Due to negligible exposure, no concern exists for exposure to the ethoxylated nonylphenols.

[d]*Hazard values refer to NOAELs, LOAELs, RfDs, or RfCs used in calculating hazard quotients or margins of exposure or slope factor used in calculating carcinogenic risk. The specific toxicologic endpoints associated with the chemicals of concern are shown in Table 2-3 "Human Health Hazard Summary"*

Blanket Wash 5

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposures to aromatic hydrocarbons and ethylene glycol ethers, and very low concern for exposure to ethoxylated nonylphenols. However, the hazard value for aromatic hydrocarbons is based upon an inhalation study. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate a very low concern for exposure to aromatic hydrocarbons and ethylene glycol ethers. Due to negligible exposure, no concern exists for the other chemicals in this formulation.

Blanket Wash 6

Worker Risk - Dermal Exposure

Margins of exposure calculations indicate concern for exposure to petroleum distillate hydrocarbons. However, the hazard value is based upon inhalation studies. Risks for other chemicals in the formulation could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. The fatty acid derivatives and alkyl benzene sulfonates are of low concern because of their expected low rate of dermal absorption and low to moderate hazard.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for exposure to petroleum distillate hydrocarbons. Due to low or negligible inhalation exposures, the petroleum distillate hydrocarbons, alkyl benzene sulfonates, and fatty acid derivatives used in this formulation present little or no concern.

Blanket Wash 7

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to terpenes and very low concern for exposure to ethoxylated nonylphenol. However, the hazard value for terpenes is based upon an oral study. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values, although none of the chemicals present more than a low to moderate hazard concern based on structure-activity analysis.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate a very low concern for exposure to terpenes. However, the hazard value is based upon an oral study. Due to low or negligible inhalation exposures, other chemicals in the formulation present little or no concern.

Table 3-9. Occupational Risks Summarized by Formulation

Form. Number	Chemicals of Concern*	Toxicologic Concern**
1	None	
3	Hydrocarbons, aromatic (inhalation and dermal exposures)	kidney effects, urinary tract and enzyme effects, reproductive and developmental effects
4	Terpenes	liver effects
5	Hydrocarbons, aromatic Ethylene glycol ethers	reproductive and developmental effects blood effects
6	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic	blood effects possible presence of carcinogens
7	Terpenes	liver effects
8	Propylene glycol ethers Hydrocarbons, aromatic	blood effects possible presence of carcinogens
9	None	
10	None	
11	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic	blood effects possible presence of carcinogens
12	Hydrocarbons, petroleum distillates	blood effects
14	None	
16	Terpenes	liver effects
17	Fatty acid derivatives	possible concern for diethanolamine component of salt
18	Hydrocarbons, petroleum distillates Dibasic esters	blood effects olfactory effects
19	None	
20	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic	blood effects possible presence of carcinogens
21	Hydrocarbons, aromatic Hydrocarbons, petroleum distillates	reproductive and developmental effects blood effects
22	Hydrocarbons, aromatic	possible presence of carcinogens
23	Terpenes Nitrogen heterocyclics	liver effects developmental effects
24	Alkyl benzene sulfonates Terpenes Ethylene glycol ethers	concern based on MOE from single dose study liver effects blood effects
25	Terpenes Esters/lactones	liver effects developmental effects
26	Esters/lactones	developmental effects

Form. Number	Chemicals of Concern*	Toxicologic Concern**
27	Terpenes	liver effects
28	Hydrocarbons, petroleum distillates	blood effects
29	None	
30	Hydrocarbons, aromatic	reproductive and developmental effects
31	Hydrocarbons, aromatic	reproductive and developmental effects
32	Insufficient data for evaluation	
33	Hydrocarbons, aromatic Hydrocarbons, petroleum distillates	reproductive and developmental effects blood effects
34	Terpenes	liver effects
35	Hydrocarbons, aromatic	reproductive and developmental effects
36	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic	blood effects possible presence of carcinogens
37	Hydrocarbons, aromatic	reproductive and developmental effects
38	Insufficient data for evaluation	
39	Hydrocarbons, petroleum distillates Propylene glycol ethers Ethylene glycol ethers Alkanolamines	blood effects blood effects blood effects blood effects
40	Hydrocarbons, petroleum distillates Hydrocarbons, aromatic	blood effects possible presence of carcinogens

* Table lists only chemicals that triggered concern. Formulations may also include other chemicals. All concerns are for dermal exposures only unless otherwise specified. Identification of chemicals of concern is based on Hazard Quotient and Margin-of-Exposure estimates shown in Table 3-8. The Hazard Quotient and Margin-of-Exposure estimates do not necessarily apply to all of the toxicologic endpoints listed in this table. Hazard Quotient and Margin-of-Exposure calculations are usually based on a "NOAEL" or the "LOAEL" for the most sensitive endpoint.

** The "Toxicologic Concern" column lists adverse effects that have been reported in the literature for animal or human studies. This is simply a qualitative listing of reported effects and does not imply anything about the severity of the effects nor the doses at which the effects occur. Furthermore, an entry in this column does not necessarily imply that EPA has reviewed the reported studies or that EPA concurs with the authors' conclusions. Toxicologic concerns are described as follows:

blood effects = hematological effects, i.e., adverse effects on blood cells
carcinogens = possible cancer causing agents
developmental effects = adverse effects on the developing embryo, fetus, or newborn
kidney effects = adverse effects on kidney physiology
liver effects = adverse effects on liver physiology
olfactory effects = adverse effects on nasal physiology
reproductive effects = adverse effects on the ability of either males or females to reproduce
"none" = no concern at predicted exposure levels

Blanket Wash 8

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate low concern for propylene glycol ethers and very low concern for ethoxylated nonylphenol. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. The other compounds in the formulation present low to moderate hazard concerns.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for propylene glycol ethers. However, the hazard value is based upon a subacute oral study. Due to low or negligible inhalation exposures, other chemicals in the formulation present little or no concern.

Blanket Wash 9

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate a very low concern for ethoxylated nonylphenol. Risks for the fatty acid derivative could not be quantified but is expected to be very low based on structure-activity predictions of low toxicity and poor dermal absorption.

Worker Risk - Inhalation Exposure

Due to negligible inhalation exposure, the chemicals used in this formulation present no concern.

Blanket Wash 10

Worker Risk - Dermal Exposure

Risk for this formulation could not be quantified but is expected to be very low based on structure-activity predictions of low toxicity and poor dermal absorption of the fatty acid derivatives.

Worker Risk - Inhalation Exposure

Due to negligible exposure, the fatty acid derivatives used in this formulation present no concern.

Blanket Wash 11

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to petroleum distillate hydrocarbons. However, the hazard value is based upon an inhalation study. Risks for the other chemicals in this formulation could not be quantified due to the unavailability of hazard values.

Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. The alkyl benzene sulfonates are of low concern because of their expected low rate of dermal absorption and low to moderate hazard.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for exposure to petroleum distillate hydrocarbons. Due to low or negligible inhalation exposures, other chemicals in the formulation present little or no concern.

Blanket Wash 12

Worker Risks - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons. However the hazard value is based upon an inhalation study. Risk could not be quantified but structure-activity analysis indicates a low to moderate hazard concern.

Worker Risks - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons. Risk could not be quantified but is expected to be low because of low exposure and low to moderate toxicity.

Blanket Wash 14

Worker Risks - Dermal Exposure

Risks for this formulation could not be quantified but are expected to be low because of structure-activity predictions of low toxicity for both the fatty acid derivatives and the propylene glycol ethers. Also, the fatty acid derivatives are expected to be poorly absorbed.

Worker Risks - Inhalation Exposure

Due to negligible exposure, the fatty acid derivatives used in this formulation present no concern. Risks for the propylene glycol ether are also expected to be low because of low exposure and its predicted low toxicity.

Blanket Wash 16

Worker Risks - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to terpenes. However, the hazard value is based upon an oral study. Risks for the other chemicals in this formulation could not be quantified due the unavailability of hazard values. Structure-activity analyses of these compounds indicates low to moderate hazard concerns.

Worker Risks - Inhalation Exposure

Margin of exposure calculations indicate very low concern for exposure to terpenes. However, the hazard value for terpenes is based upon an oral study. Risks for the other chemicals in this formulation could not be quantified but are expected to be low because of low exposures and low to moderate toxicity.

Blanket Wash 17

Worker Risks - Dermal Exposure

Hazard quotient calculations indicate very low concern for propylene glycol ethers. However, the hazard value is based upon an oral study. Margin of exposure calculations indicate very low concern for ethoxylated nonylphenol and alkali/salts. However, the hazard value for alkali salts is based upon oral values. The alkanolamine component of the fatty acid derivative/alkanolamine salt presents a possible concern. However, dermal absorption of the alkanolamine salt is likely to be lower than that of free alkanolamine.

Worker Risks - Inhalation Exposure

Hazard quotient calculations indicate no concern for glycols. However, the hazard value is based upon an oral study. Due to negligible inhalation exposure, ethoxylated nonylphenol, fatty acid derivatives and alkali/salts present very low concern.

Blanket Wash 18

Worker Risks - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons and dibasic esters. However, the hazard values are based on inhalation studies. Risk from the alkyl benzene sulfonates could not be quantified but is expected to be low because of structure-activity predictions of poor absorption and low to moderate toxicity. Risk from esters/lactones is also expected to be low based on structure-activity predictions of low toxicity.

Worker Risks - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons and dibasic esters. Risks for other chemicals in this formulation could not be quantified but are expected to be low due to low or negligible exposures and low to moderate hazard concerns.

Blanket Wash 19

Worker Risk - Dermal Exposure

Risks for this formulation could not be calculated due to the unavailability of hazard values. However, risks are expected to be low based on structure-activity predictions of low toxicity of propylene glycol ethers and poor absorption and low to moderate toxicity of the fatty acid derivatives.

Worker Risk - Inhalation Exposure

Due to negligible exposure, the fatty acid derivatives present no concern. Risks for propylene glycol ethers are expected to be low because of low exposure and low hazard concern.

Blanket Wash 20

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons. However, the hazard value is based upon an inhalation study. Risks for the other chemicals in this formulation could not be quantified due to the unavailability of hazard values. Risk from the alkyl benzene sulfonates is

expected to be low because of structure-activity predictions of poor absorption and low to moderate toxicity. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons. Risks for other chemicals in this formulation could not be quantified but are expected to be low due to low or negligible exposures and low to moderate hazard concerns.

Blanket Wash 21

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for aromatic hydrocarbons and petroleum distillate hydrocarbons. However, the hazard values are based upon inhalation studies. Risk for the fatty acid derivatives could not be quantified but are expected to be low based on structure-activity predictions of poor absorption and low toxicity.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for aromatic hydrocarbons and petroleum distillate hydrocarbons. Due to negligible exposure and predicted low toxicity and absorption, fatty acid derivatives presents no concern.

Blanket Wash 22

Worker Risk - Dermal Exposure

Risks for this formulation could not be calculated due to the unavailability of hazard values. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. Risks from the fatty acid derivatives are expected to be low based on structure-activity predictions of poor absorption and low to moderate toxicity.

Worker Risk - Inhalation Exposure

Risks could not be quantified but are expected to be low due to low or negligible exposures.

Blanket Wash 23

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate possible concerns for terpenes and nitrogen heterocyclics. However, the hazard value for terpenes is based upon an oral study. Risks for the alkoxylated alcohols could not be quantified but are expected to be low based on structure-activity predictions of poor absorption and low to moderate toxicity.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for terpenes and nitrogen heterocyclics. However, the hazard value for terpenes is based upon an oral study. Risks for the alkoxylated alcohols could not be quantified but are expected to be low based on low exposure and structure-activity predictions of poor absorption and low to moderate toxicity.

Blanket Wash 24

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for alkyl benzene sulfonates and terpenes, possible concern for ethylene glycol ethers, and very low concern for ethoxylated nonylphenol. However, the hazard value for terpenes is based upon an oral study. Risks for alkali/salts could not be quantified but are expected to be very low based on structure-activity predictions of no absorption and low to moderate toxicity.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for terpenes and ethylene glycol ethers. However, the hazard value for terpenes is based upon an oral study. Due to negligible exposure, the other chemicals in this formulation present no concern.

Blanket Wash 25

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to terpenes and possible concern for exposure to esters/lactones. However, the hazard values are based upon oral studies. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values. The other chemicals are all terpene-type compounds and are rated as low to moderate hazard concern based on structure-activity analysis.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for exposure to terpenes and esters/lactones. However, the hazard values are based upon oral studies. Risks for other chemicals in this formulation could not be quantified but are expected to be low based on low exposure and structure-activity predictions of low to moderate toxicity.

Blanket Wash 26

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for esters/lactones, and very low concern for the fatty acid derivatives. However, the hazard values are based upon oral studies. Risks for the fatty acid derivatives could not be quantified but are expected to be low because of structure-activity predictions of poor absorption and low toxicity.

Worker Risk - Inhalation Exposure

Due to negligible exposure, the chemicals used in this formulation present no concern.

Blanket Wash 27

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for terpenes. However, the hazard value is based upon an oral study. Risks for other chemicals in this formulation could not be quantified due to the

unavailability of hazard values. The other chemicals are all terpene-type compounds and are rated as low to moderate hazard concern based on structure-activity analysis.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for terpenes. However, the hazard value is based upon an oral study. Risks for other chemicals in this formulation could not be quantified but are expected to be low based on low exposure and structure-activity predictions of low to moderate toxicity.

Blanket Wash 28

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons. However, the hazard value is based upon an inhalation study.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate low concern for petroleum distillate hydrocarbons.

Blanket Wash 29

Worker Risk - Dermal Exposure

Risks for this formulation could not be quantified but are expected to be low because of structure-activity predictions of poor absorption and low toxicity for the fatty acid derivatives.

Worker Risk - Inhalation Exposure

Due to negligible exposure, the chemicals in this formulation present no concern.

Blanket Wash 30

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for aromatic hydrocarbons. However, the hazard value is based upon an inhalation study. Risks for propylene glycol ethers could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates low hazard concern for propylene glycol ethers.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for aromatic hydrocarbons. Risks for propylene glycol ethers could not be quantified but are expected to be low based on low exposure and structure-activity predictions of low toxicity.

Blanket Wash 31

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for exposure to aromatic hydrocarbons. However, the hazard value is based upon an inhalation study. Risks for petroleum distillate hydrocarbons could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates low to moderate hazard concern for petroleum distillate hydrocarbons.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for exposure to aromatic hydrocarbons. Risks for petroleum distillate hydrocarbons could not be quantified but are expected to be low based on low exposure and structure-activity predictions of low to moderate toxicity.

Blanket Wash 32

Worker Risk

Risks for this formulation could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates low to moderate hazard concern for petroleum distillate hydrocarbons.

Blanket Wash 33

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons and aromatic hydrocarbons, and very low concerns for propylene glycol ethers. However, the hazard values for petroleum distillate hydrocarbons and aromatic hydrocarbons are based upon an inhalation study.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons, aromatic hydrocarbons, and propylene glycol ethers.

Blanket Wash 34

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concerns for terpenes and very low concerns for the fatty acid derivatives. However, the hazard values are based upon oral studies. Risks for fatty acid derivatives could not be quantified but are expected to be low because of structure-activity predictions of poor absorption and low to moderate toxicity. Risks for petroleum distillate hydrocarbons could not be quantified. Structure-activity analysis indicates low to moderate hazard concern for these chemicals.

Worker Risk - Inhalation Exposure

Margin of exposure values indicate very low concern for terpenes. However, the hazard value is based upon an oral study. Due to negligible exposure, the fatty acid derivatives present no concern. Risks for petroleum distillate hydrocarbons could not be quantified but are expected to be low because of low exposure and structure-activity predictions of low to moderate hazard concern.

Blanket Wash 35

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for aromatic hydrocarbons. However, the hazard value is based upon an inhalation study. Risks for petroleum distillate hydrocarbons could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates low to moderate hazard concern for petroleum distillate hydrocarbons.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for aromatic hydrocarbons. Risks for petroleum distillate hydrocarbons could not be quantified but are expected to be low based on low exposure and structure-activity predictions of low to moderate toxicity.

Blanket Wash 36

Worker Risk - Dermal Exposure

Margin of exposure calculation indicate concern for petroleum distillate hydrocarbons, and very low concern for propylene glycol ethers. However, the hazard value for petroleum distillate hydrocarbons is based upon an inhalation study. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. Risks from fatty acid derivatives are expected to be low because of structure-activity predictions of poor absorption and low toxicity.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons and propylene glycol ethers. Due to negligible exposure, the fatty acid derivatives present no concern. Risks from aromatic hydrocarbons could not be quantified but are expected to be low because of low exposure.

Blanket Wash 37

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate possible concern for aromatic hydrocarbons. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values. The petroleum distillate hydrocarbons are considered to present low to moderate hazard concerns according to structure-activity analysis.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for aromatic hydrocarbons. Risks for other chemicals in this formulation could not be quantified but are expected to be low because of low exposure and structure-activity predictions of low to moderate hazard.

Blanket Wash 38

Worker Risk - Dermal Exposure

Risks for this formulation could not be quantified due to the unavailability of hazard values. The fatty acid derivatives and alkoxylated alcohols are expected to present low risk because of structure-activity predictions of poor absorption and low or low to moderate toxicity. Petroleum distillate hydrocarbons present low to moderate hazard concern according to structure-activity analysis.

Worker Risk - Inhalation Exposure

Due to negligible exposure, the fatty acid derivatives present no concern. Risks for petroleum distillate hydrocarbons could not be quantified but are expected to be low because of low exposure and structure-activity predictions of low to moderate toxicity.

Blanket Wash 39

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons, ethylene glycol ethers, and alkanolamines, and possible concerns for propylene glycol ethers. However, the hazard value for petroleum distillate hydrocarbons is based on an inhalation study.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons, propylene glycol ethers, and ethylene glycol ethers. However, the hazard value used for propylene glycol ethers is based on an oral study. Due to negligible exposure, alkanolamines present no concern.

Blanket Wash 40

Worker Risk - Dermal Exposure

Margin of exposure calculations indicate concern for petroleum distillate hydrocarbons and very low concern for ethoxylated nonylphenol. However, the hazard value for petroleum distillate hydrocarbons is based upon an inhalation study. Risks for other chemicals in this formulation could not be quantified due to the unavailability of hazard values. Structure-activity analysis indicates a moderate hazard concern for aromatic hydrocarbons because of the possible presence of carcinogenic compounds. Risks from fatty acid derivatives are expected to be low because of structure-activity predictions of poor absorption and low toxicity.

Worker Risk - Inhalation Exposure

Margin of exposure calculations indicate very low concern for petroleum distillate hydrocarbons. Due to negligible exposure, fatty acid derivatives and ethoxylated nonylphenol present no concern. Risks from aromatic hydrocarbons could not be quantified but are expected to be low because of low exposure.

3.4.4 General Population Risks

No concerns were identified for general population exposures through drinking water, fish ingestion, or ambient air as seen in Table 3-10. Predicted exposure levels in these environmental media were extremely low. The calculated risk numbers should be viewed as low-confidence estimates because of the many uncertainties associated with both the hazard and exposure components of the calculation. However, the overall risk conclusion can be regarded with high confidence because all of the risk estimates fall far below standard risk benchmarks. Thus, the "true" risk value could vary substantially from the estimated value without changing the conclusion. In addition, a generally conservative approach (i.e. one that overestimates the risk) was taken in the assessment.

A Margin-of-Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater is the level of concern. High MOE values such as values greater than 100 for a NOAEL-based MOE or 100 for a LOAEL-based MOE imply a low level of concern. As the MOE decreases, the level of concern increases. The hazard values used in the HQ or MOE calculations were taken from Table 2-3. The exposure values used in the calculations were taken from Table 3-4. The absence of HQ or MOE values in this table indicates that insufficient hazard data were available to calculate a HQ or MOE for that chemical.

Table 3-10. General Population Risk Estimates for Drinking Water, Fish Ingestion, and Inhalation

Form. Number	Chemical Components	Drinking Water MOE[1,2]	Fish Ingestion MOE[1,2]	Inhalation MOE[1,2]
1	Fatty acid derivatives			
	Alkoxylated alcohols			
3	Hydrocarbons, petroleum distillates			
	Fatty acid derivatives			
	Hydrocarbons, aromatic			1.6×10^{5}
	Hydrocarbons, aromatic			2.0×10^{4}
	Hydrocarbons, aromatic			3.0×10^{-5} (HQ)
	Hydrocarbons, aromatic			7.1×10^{-5} (HQ)
	Alkyl benzene sulfonates			
4	Terpenes			8.0×10^{4}
	Ethoxylated nonylphenol[3]	8.8×10^{5}		
5	Water			
	Hydrocarbons, aromatic			1.2×10^{5}
	Ethylene glycol ethers			4.5×10^{4}
	Ethoxylated nonylphenol[3]	7×10^{6}		
	Alkyl benzene sulfonates			
	Alkoxylated alcohols			
	Alkyl benzene sulfonates			
	Alkali/salts			
6	Fatty acid derivatives			
	Hydrocarbons, petroleum distillates			6.0×10^{5}
	Hydrocarbons, aromatic			
	Alkyl benzene sulfonates			
7	Terpenes			
	Terpenes			3.0×10^{5}
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Ethoxylated nonylphenol[3]	2.3×10^{7}		
	Alkoxylated alcohols			

Form. Number	Chemical Components	Drinking Water MOE[1,2]	Fish Ingestion MOE[1,2]	Inhalation MOE[1,2]
8	Water			
	Hydrocarbons, aromatic			
	Propylene glycol ethers			7.0×10^5
	Alkyl benzene sulfonates	5.0×10^7		
	Ethoxylated nonylphenol[3]	8.1×10^6		
	Alkyl benzene sulfonates			
	Alkoxylated alcohols			
	Alkyl benzene sulfonates			
	Alkali/salts			
9	Fatty acid derivatives			
	Water			
	Ethoxylated nonylphenol[3]	2.3×10^7		
10	Fatty acid derivatives			
	Water			
11	Fatty acid derivatives			
	Hydrocarbons, petroleum distillates			4.0×10^5
	Hydrocarbons, aromatic			
	Alkyl benzene sulfonates			
12	Hydrocarbons, petroleum distillates			
	Hydrocarbons, petroleum distillates			2.0×10^6
	Water			
14	Fatty acid derivatives			
	Propylene glycol ethers			
	Water			
16	Terpenes			3.0×10^5
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
17	Ethoxylated nonylphenol[3]	3.2×10^7		
	Glycols			1.0×10^{-5} (HQ)
	Fatty acid derivatives			
	Alkali/salts			
	Water			

Form. Number	Chemical Components	Drinking Water MOE[1,2]	Fish Ingestion MOE[1,2]	Inhalation MOE[1,2]
18	Fatty acid derivatives			
	Hydrocarbons, petroleum distillates			4.0×10^5
	Hydrocarbons, aromatic			
	Dibasic esters			3.0×10^4
	Dibasic esters			3.0×10^4
	Dibasic esters			3.0×10^4
	Esters/lactones			
	Alkyl benzene sulfonates			
19	Fatty acid derivatives			
	Propylene glycol ethers			
	Water			
20	Water			
	Hydrocarbons, petroleum distillates			8.0×10^5
	Hydrocarbons, aromatic			
	Alkyl benzene sulfonates			
21	Hydrocarbons, aromatic			2.5×10^5
	Hydrocarbons, petroleum distillates			1.0×10^5
	Fatty acid derivatives			
22	Fatty acid derivatives			
	Hydrocarbons, aromatic			
	Water			
23	Terpenes			1.0×10^5
	Nitrogen heterocyclics			1.0×10^4
	Alkoxylated alcohols			
	Water			
24	Terpenes			4.0×10^5
	Ethylene glycol ethers			1.1×10^4
	Ethoxylated nonylphenol[3]	1.5×10^7		
	Alkyl benzene sulfonates	5.0×10^6		
	Alkali/salts			
	Water			
25	Terpenes			
	Terpenes			3.0×10^5
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Esters/lactones			2.0×10^6

Form. Number	Chemical Components	Drinking Water MOE[1,2]	Fish Ingestion MOE[1,2]	Inhalation MOE[1,2]
26	Fatty acid derivatives			
	Esters/lactones			
	Fatty acid derivatives	1.3×10^8	6.3×10^5	
	Esters/lactones			
27	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			
	Terpenes			6.0×10^5
	Terpenes			
	Terpenes			
28	Hydrocarbons, petroleum distillates			1.2×10^5
29	Fatty acid derivatives			
30	Hydrocarbons, aromatic			7.0×10^4
	Propylene glycol ethers			
	Water			
31	Hydrocarbons, aromatic			2.5×10^5
	Hydrocarbons, petroleum distillates			
32	Hydrocarbons, petroleum distillates			
33	Hydrocarbons, petroleum distillates			2.0×10^5
	Hydrocarbons, aromatic			1.6×10^5
	Propylene glycol ethers			1.0×10^6
	Water			
34	Water			
	Terpenes			4.0×10^5
	Hydrocarbons, petroleum distillates			
	Alkoxylated alcohols	6.0×10^7		
	Fatty acid derivatives			
35	Hydrocarbons, petroleum distillates			
	Hydrocarbons, aromatic			3.0×10^4
36	Fatty acid derivatives			
	Hydrocarbons, petroleum distillates			8.0×10^5
	Hydrocarbons, aromatic			
	Propylene glycol ethers			2.0×10^6
37	D. I. Water			
	Hydrocarbons, petroleum distillates			
	Hydrocarbons, aliphatic			
	Hydrocarbons, aromatic			1.2×10^5

Form. Number	Chemical Components	Drinking Water MOE[1,2]	Fish Ingestion MOE[1,2]	Inhalation MOE[1,2]
38	Hydrocarbons, petroleum distillates			
	Alkoxylated alcohols			
	Fatty acid derivatives			
39	Water			
	Hydrocarbons, petroleum distillates			8.0×10^5
	Propylene glycol ethers			1.0×10^6
	Alkanolamines	4.0×10^6		
	Ethylene glycol ethers			1.1×10^5
40	Hydrocarbons, aromatic			
	Hydrocarbons, petroleum distillates			8.0×10^5
	Fatty acid derivatives			
	Ethoxylated nonylphenol[3]	1.6×10^7		

[1] A Margin-of-Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater is the level of concern. High MOE values such as values greater that 100 for a NOAEL-based MOE or 100 for a LOAEL-based MOE imply a low level of concern. As the MOE decreases, the level of concern increases. The hazard values used in the HQ or MOE calculations were taken from Table 2-3. The exposure values used in the calculations were taken from Tables 3-4 and 3-5.

[2] The absence of HQ or MOE values in this table indicates no exposure is expected by this route or that insufficient hazard data were available to calculate a HQ or MOE for that chemical.

[3] Based on testing data (Weeks, A.J. et al. 1996. *Proceedings of the CESIO 4th World Surfactants Congress, Barcelona, Spain*. Brussels, Belgium: European Committee on Surfactants and Detergents, pp. 276-291.) the original estimate of POTW removal has been changed from 100% reported in the draft document to 95% in the final report. This revision results in increased estimates of releases to surface water. When the releases to surface water are compared with the concern concentration set at the default value of 0.001 mg/L, the formulations containing ethoxylated nonylphenols (formulations 4, 5, 7, 8, 9, 17, 24 and 40) present concerns to aquatic species that were not reported in the draft CTSA.

3.5 PROCESS SAFETY CONCERNS

Exposure to chemicals is just one of the safety issues that printers may have to deal with during their daily activities. Preventing worker injuries should be a primary concern for employers and employees alike. Work-related injuries may result from faulty equipment, improper use of equipment or bypassing equipment safety features, failure to use personal protective equipment, and physical stresses that may appear gradually as a result of repetitive motions (i.e., ergonomic stresses). Any or all of these types of injuries may occur if proper safeguards or practices are not in place and correctly used. The use of personal safety equipment and the presence of safety guards on equipment can have a substantial impact on business, not only in terms of direct worker safety, but also in reduced operating costs as a result of fewer days of absenteeism, reduced accidents and injuries, and lower insurance costs. Maintaining a safe and efficient workplace requires that employers and employees understand the importance of using personal protective equipment, have appropriate safeguards on mechanical and electrical equipment, store and use chemicals properly, and practice good ergonomic procedures when engaged in physical activity.